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Flyrock: The "Hits" Just Keep On Coming!

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ABSTRACT

Despite all claims to the contrary, flyrock debris is an inherent and unavoidable byproduct of blasting operations. Wherever blasting occurs, flyrock debris is sure to follow. It is influenced by numerous and unpredictable factors, including blast design limitations, uneven energy distribution, varying atmospheric conditions, human or operational errors, and the inherently dynamic nature of blasting, Additionally, geological inconsistencies, such as variations in rock density, fractures and fault lines, further amplify the unpredictability of flyrock incidents. Flyrock debris poses significant risks to safety, infrastructure, and nearby properties. While blasting has other adverse effects, flyrock is considered the most dangerous due to its potential to injure, permanently disable, or kill on contact. It is responsible for the majority of onsite and offsite injuries and fatalities in blasting operations, many of which could be prevented by enacting mandatory minimum onsite setbacks and mandatory minimum offsite separation distances from sensitive land uses and activities. In Ontario, flyrock remains undefined under the Aggregate Resources Act (ARA), effectively allowing the aggregate industry to avoid regulatory oversight. If flyrock incidents do not result in debris leaving the site or causing injury or death, they remain concealed from the public and unreported to regulating authorities. This lack of mandatory disclosure exacerbates the issue, leaving communities vulnerable to unaddressed hazards. The implementation of mandatory minimum setbacks and separation distances is essential to safeguarding the safety of workers and surrounding communities.

Keywords: Flyrock; Blasting; Aggregate extraction; Environmental impacts; Land use incompatibility

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1. INTRODUCTION

Since 2020, International Forensic and Litigation Appraisal Services Inc. (IFLAS) has been diligently researching and documenting the dangers of *Flyrock*, an unavoidable and unpredictable by-product of blasting rock. *Flyrock* represents the ultimate *adverse effect*,[1] and is broadly defined as follows:

> *Flyrock means any material (e.g., gravel, rocks, tree trunks, construction materials, mud, or even water) propelled by a blast that is actually or potentially hazardous to persons or property onsite or offsite.*

Blasting operations are expected to generate flyrock debris, and the distance launched can significantly impact the surrounding environment (Mishra & Rout, 2012). Flyrock debris comes in all shapes, sizes, and weights, and can launch or shower in multiple directions over a considerable distance, and at great speed, reaching up to 400 miles per hour. As of May 2025, the statistics reveal a total of 256 flyrock incidents onsite and offsite, 49 of which resulted in death. This translates to a staggering "kill" rate of 19.1% (49 ÷ 256), making blasting rock one of the most perilous industrial activities.

Concealment and underreporting of flyrock incidents by the aggregate industry are significant issues that have left the public uninformed and vulnerable. This deliberate lack of disclosure and transparency not only obscures the true extent of the risks associated with flyrock but also impedes regulators and municipalities from taking effective precautions to protect their residents. Proactively addressing this alarming problem is crucial to ensuring the health, safety, and well-being of those living, working, or playing near blasting operations. Mandatory minimum onsite setbacks coupled with mandatory minimum offsite separation distances of appropriate width or radius are the only effective measures to eliminate the risks of flyrock from blasting rock.

2. FACTORS INVOLVED IN THE UNDERREPORTING OF FLYROCK INCIDENTS

Despite the well-documented dangers associated with flyrock incidents, many cases go unreported for a variety of reasons. Underreporting not only skews industry statistics but also undermines efforts to improve safety protocols and mitigate risks in blasting operations. Several key factors contribute to this lack of accurate reporting, ranging from workplace culture and management pressure to regulatory shortcomings and environmental considerations. Understanding these influences is essential for addressing gaps in safety and ensuring a more transparent approach to flyrock incident documentation. Such factor are as under:

1. *Lack of Awareness:* Workers and site managers may not fully understand the risks associated with flyrock, leading to underreporting.
2. *Fear of Repercussions:* Employees might fear disciplinary action or job loss if they report a flyrock incident, especially if it was due to a mistake, incompetence, or negligence.
3. *Fear of Penalties:* Employees and site managers may fear financial penalties, legal actions, or other consequences if they report a flyrock incident. This may involve cleaning up or removing debris and damaged property before it can be reported.
4. *Intentional Concealment:* Workers or site managers may intentionally conceal flyrock incidents to avoid penalties, legal actions, or other repercussions.
5. *Pressure to Meet Production Targets:* High production demands can create pressure to avoid disruptions and investigations caused by reporting flyrock incidents.
6. *Pressure from Management:* Employees may be pressured by management to avoid reporting flyrock incidents to maintain a positive safety record and to avoid increases in insurance premiums due to the potential for property damage, injury, permanent disability, or death.
7. *Lack of Training and Awareness:* Employees may not fully understand the importance of reporting flyrock incidents or may lack proper training on how to do so.
8. *Inadequate Reporting Systems:* Some sites may lack proper reporting mechanisms or protocols, making it difficult for workers to report flyrock incidents accurately.

[1] CPR< September 18, 2023, PL-51-23, Correspondence from Tony Sevelka. https://www.caledon.ca/en/town-services/resources/Business-Planning--Development/Policy/Aggregates/Aggregate-Supplementary-Group/Sub-Group/Correspondence-from-Tony-Sevelka---City-of-Burlington-Flyrock-Presentation.pdf?form=MG0AV3&form=MG0AV3

9. *Regulatory Gaps:* In some regions, such as Ontario, Canada, there may be insufficient regulatory oversight or enforcement, leading to a lack of accurate data on flyrock incidents.
10. *Lack of Accountability:* In jurisdictions such as Ontario, Canada, where there is minimal oversight or accountability, there is a greater likelihood of flyrock incidents being concealed.
11. *Remote Locations:* Flyrock incidents in remote or less monitored areas (e.g., forests, tree stands, rivers, ponds, lakes, seasonal trailways) may go unnoticed for extended periods or never recognized as flyrock debris.
12. *Minimal Immediate Impact:* Some flyrock incidents may not cause immediate visible damage, leading to delayed recognition and reporting (e.g., intermittent use of farm equipment damaged by soil-covered flyrock debris).
13. *Environmental Impact:* Flyrock debris can cause damage to natural habitats, farmland, and infrastructure, which may not be immediately apparent.
14. *Flyrock Stays on Site:* If flyrock does not leave the site, it often goes unreported regardless of the distance travelled, as it may not be considered a significant incident in jurisdictions such as Ontario, Canada.

Addressing these factors requires a combination of better education, improved reporting systems, and stronger regulatory oversight and enforcement. Implementing comprehensive safety training programs and fostering a culture of transparency and accountability can also help reduce the incidence of flyrock and ensure that all incidents are properly documented, addressed, and publicly disclosed in sufficient detail and made readily available on the internet.

3. MNRF'S FAILURE TO PROTECT THE PUBLIC SAFETY FROM FLYROCK

Alarmingly, despite the severe and potentially lethal consequences of flyrock, the Ministry of Natural Resources and Forestry (MNRF) has shown a blatant lack of interest or desire to effectively address the issue. There is a notable absence of accountability measures for explosives engineers conducting proponent-driven studies, which often either ignore or fail to fully disclose that flyrock is an unavoidable and unpredictable consequence of blasting rock. Shockingly, MNRF has never conducted a study of flyrock incidents, and the Aggregate Resources Act.[2] administered by MNRF is woefully inadequate in safeguarding the health and safety of the public and the environment. The following critical deficiencies highlight systemic issues that undermine public safety and environmental responsibility in the regulation of flyrock in Ontario:

- *No Definition of Fyrock:* The lack of a clear definition hinders the consistent reporting and regulation of incidents, making it difficult to enforce safety measures.
- *No Protocols to Prevent Flyrock from Leaving the Site:* This absence allows for unpredictable and dangerous occurrences, increasing the risk to surrounding communities and environments.
- *Recklessly Inadequate Permanent Onsite Setback (excavation limit):* ARA's 30-metre setback (excavation limit) is unsupported and does not reflect the true range of flyrock debris, as evidenced by the quantitative analysis of 147 flyrock incidents. This endangers both onsite workers and anyone offsite in the neighbouring communities.
- *No Onsite Blast Exclusion Zone:* Without designated exclusion zones, employees are left vulnerable to flyrock, which can cause severe injuries, permanent disabilities, or fatalities.
- *No Licensing Requirement for the Blaster-In-Charge:* The absence of a licensing requirement means there is no assurance that the individual responsible for handling and detonating explosives is competent and knowledgeable, increasing the risk of accidents.
- *No Mandatory Comprehensive Environmental Assessments:* Without thorough environmental assessments, the long-term impacts of flyrock on ecosystems and communities remain unaddressed, potentially causing irreversible damage.
- *No Obligation for Public Disclosure of Flyrock Incidents:* This lack of transparency prevents the public from being informed about the risks and occurrences of flyrock incidents, reducing public awareness and accountability.

[2] Aggregate Resources Act, R.S.O., 1990, c. A.8. https://www.ontario.ca/laws/statute/90a08 Retrieved February 28, 2025.

- *No Advisories Warning the Public of the Dangers of Fyrock:* The absence of public advisories leaves communities uninformed and unprepared for the potential dangers, increasing the likelihood of harm in the event of an incident.
- *Inadequate Data Collection:* Without systematic data collection on flyrock incidents, it is impossible to analyze patterns and develop effective regulations.
- *Reliance on Self-Regulation of Aggregate Industry:* Over-reliance on self-regulation leads to conflicts of interest and insufficient oversight, allowing companies to prioritize production and profit over safety without facing significant consequences.

This lack of effective oversight and regulatory enforcement by the MNRF not only endangers the health and safety of the public and workers but also perpetuates a culture of negligence and underreporting within the aggregate industry.

4. MUNICIPAL LAND USE CONTROLS TO PROTECT RESIDENTS FROM FLYROCK

To overcome MNRF's gross negligence, municipalities must implement stringent land use controls focused on addressing land use incompatibility. This includes enacting permanent minimum onsite setbacks (excavation limits) and permanent minimum offsite separation distances from sensitive land uses and activities. From the beginning of 2020 to May 2025, Sevelka (2022, 2023) has meticulously recorded 256 (known) individual *flyrock* incidents from various sources, including news releases, published investigations, scholarly journals, and case law. These incidents have been thoroughly documented and summarized below.

4.1 Summary of Flyrock Incidents

- Previously, a total of approximately 195 flyrock incidents had been discovered and analyzed (Sevelka, 2022). Of the 195 flyrock incidents discovered, 33 resulted in death, indicating an overall kill rate of 16.9%, and 40 people were injured in the same 33 flyrock incidents.
- An additional 24 flyrock incidents were added to the "running list" of flyrock incidents, bringing the total to 219 (Sevelka, 2023). Of these additional 24 flyrock incidents, 10 people were injured, and 4 people were killed, indicating a kill rate of 16.7% (4 ÷ 24). Of the 219 flyrock incidents documented, 37 resulted in death from being struck by flyrock debris, reflecting a "kill" rate of 16.9% (37 ÷ 219), and 41 more people were injured in the same 37 flyrock incidents.
- An additional 21 flyrock incidents were added to the "running list," increasing the total of known flyrock incidents from 219 to 240 (Sevelka, 2024). Of the 8 of these 21 additional flyrock incidents documented, 12 people were killed and 8 people were injured. Of the 240 flyrock incidents, 45 resulted in death, indicating a "kill" rate of 18.8% (45 ÷ 240). In those same 45 flyrock incidents, 49 people were killed and an equal number were injured.
- An additional 16 flyrock incidents have been added to the "running list" of flyrock incidents, bringing the total to 256 as of May 2025. In those additional 16 flyrock incidents, 8 people were killed, and 62 were injured. In 4 of these 16 additional flyrock incidents, 8 people were killed and 46 people were injured. Of the 256 flyrock incidents, 49 resulted in death, indicating a "kill" rate of 19.1% (49 ÷ 256). Additionally, in those same 49 flyrock incidents, 103 people were injured.

The kill rate in flyrock incidents has shown a gradual increase over time rather than remaining completely consistent. Here is how it has changed:

4.2 Kill Rate Over Time

- 2022: 16.9% (33 deaths out of 195 incidents)
- 2023: 16.9% (37 deaths out of 219 incidents) → Stable
- 2024: 18.8% (45 deaths out of 240 incidents) → Increase
- 2025: 19.1% (49 deaths out of 256 incidents) → Slight increase

While the kill rate was consistent from 2022 to 2023, it increased in 2024 and 2025, suggesting worsening safety conditions or larger-scale blasts. The trend indicates that flyrock incidents are becoming deadlier, possibly due to urban expansion, stronger explosives, or insufficient safety measures.

4.3 "Running List" of Flyrock Incidents

Relevant details of the 16 most recent *flyrock incidents* uncovered are summarized as follows:

- *Flyrock 241:* On June 6, 2022, a blast at a construction site in Hendersonville, Tenn., launched *flyrock debris* that rained down on the neighbouring Stonecrest subdivision, striking at least three homes (Lamb, 2022).

  > *In the video, the rocks fly so fast that it's hard to spot them. But in one frame, a rock projectile is seen flying through the air, about to impale a garage door. As the dust clears in the video, neighbors try to figure out what's going on…. Even a day later, rocks from the blast were still visible in the neighborhood, lying on the ground.*
  >
  > *…[S]eismic readings showed the power of yesterday's blast was within legal limits and the same strength as other blasts that have been going on for two years.*

- *Flyrock 242:* On August 29, 2007, a blast at a quarry near Athens, Greece, launched *flyrock debris* resulting in damage to the Lambropoulou family home more than a kilometre (>1,000 metres) away as two large rocks landed on their house, causing damage to the roof, a wall and injuring one person.[3]

- *Flyrock 243:* On October 14, 2024, a blast at a construction site at Buduburam, Ghana, launched *flyrock debris* that showered a neighbouring community with catastrophic consequences, killing three individuals on the spot, including Thomas Kofi and two females (Frimpong, 2024) and injuring 45 others. Vehicles, homes, and businesses were also damaged by flyrock debris.[4]

  > *At St. Gregory Catholic Hospital in Budumburam, more than 45 victims were admitted on Monday, October 13, following the devastating blast. By the first day, 34 victims with minor injuries had been discharged, but 13 remain under close watch.*
  >
  > *Residents of Budumburam claim this isn't the first time rock blasting has endangered their lives. The blasts have often damaged homes, leaving behind holes in walls and fear in their hearts. This time, however, the rocks have taken more than property; they've taken lives.*

- *Flyrock 244:* On January 6, 2025, a blast at a quarry in Valillapuzha, India, launched *flyrock debris,* including a rock that penetrated a house and struck a pregnant woman, Farbeena, in the leg while she was sleeping. She was admitted to Areekode Taluk Hospital for treatment. Residents reported that a similar incident had occurred a month prior and criticized the authorities for failing to address safety concerns at the quarry despite repeated mishaps.[5]

- *Flyrock 245:* On September 19, 2016, a blast at the construction of a bypass in Aberdeen, Scotland, launched *flyrock debris* that smashed and caved in the roof of a 4 x 4 Toyota within a 600-foot (183 metres) exclusion zone (Beattle, 2016).

  > *Transport bosses launched an investigation after a boulder smashed through the roof of the 4×4 during the blast. The incident is understood to have taken place in the Rothnick area of the southern section of the £750 million bypass during blasting works, close to Netherley Road. Although a safety exclusion zone of more than 600ft [183 metres] was in place, the Toyota was parked too close and was struck by a flying rock, shattering the windshield and caving in the roof.*

- *Flyrock 246:* On May 14, 2004, a blast at a construction site in New Rochelle, N.Y., launched *flyrock debris* that damaged 40 cars at a Hyundai dealership and injured five people.[6]

  > *A dynamite explosion at an excavation site blasted hundreds of rocks as big as beach balls across a street, breaking windows and damaging new cars at a dealership. Five people sustained minor injuries.*
  >
  > *The explosion was ``like a gunshot of rocks across the street," Phil Saporito, plant manager at the Hyundai dealership, said, standing outside a showroom filled with cracked glass and dented cars. At least 40 cars were damaged.*

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[3] "Quarry rocks rain on home," *ekathimerine.com*, August 31, 2007, https://www.ekathimerini.com/news/51532/quarry-rocks-rain-on-home/.

[4] "How flying rocks killed 3 persons at Buduburam," *GH Environment*, October 16, 2024, https://ghenvironment.com/Environment_Sanitation/update-how-flying-rocks-killed-3-persons-at-buduburam1729059977.

[5] "Rock from quarry blast crashes into house in Kozhikode; pregnant woman injured." *Onmanorama,* January 6, 2025. https://www.onmanorama.com/news/kerala/2025/01/06/kozhikode-pregnant-woman-injured-quarry-blast.html

[6] "Blast Sends Rocks Flying, Dents New Cars," *Firehouse*, May 14, 2004. https://www.firehouse.com/home/news/10519394/blast-sends-rocks-flying-dents-new-cars

> *Main Street had been closed to traffic before the blast at a site being readied for stores. A heavy, rubber mat that was being used to contain the blast failed. ``One end of the mat lifted," Fire Chief Frank Strollo said. ``It wasn't enough coverage." Owner Ray Hayduk Jr. said the blast area wasn't solid rock. ``That's why it came out so fast. There was a natural seam in the rock, and we drilled right into it," he said.*

- *Flyrock 247:* On August 22, 2003, a blast at a construction site launched *flyrock debris* that struck three condos at Forrest Drive Manor B, Yellowknife (Collins, 2003).

  > *No one was injured in the explosion set by NWT Rock Services, but flying rock tore through the roof of one condo and the wall of another, breaking a door and a window. "The wall above my living room window is cracked," said Shirley McGrath, who lives on the first floor.*
  >
  > *Lance Gomolchuk, operations manager for NWT Rock Services, said there wasn't enough explosive in the first hole of an eight-hole shot. Since the first hole didn't blast enough rock, "it caused the number five hole to do twice as much work," Golumchuk said. The energy from the first blast went up and threw off the blasting mats, leaving the number five hole uncovered when it went off, Gomolchuk said. "It shot up and threw a rock," he said.*

- *Flyrock 248:* On September 28, 2024, a blast at a construction site launched *flyrock debris* that struck and killed 25-year-old Ajit Kumar Bhuskun Shah and injured Ram Pravesh and Rahul Ramprasad in Mangrul Village, India (Inamdar, 2024).

  > *A man died while two others were injured during a controlled blasting underway at a plot in Talegaon MIDC. According to the police, the complainant, injured and deceased, was working inside the Comos company premises when a flying stone from the blasting site owned by Arun Bhegade hit Shah's head, leading to a serious head injury and death instantaneously.*
  >
  > *"The plot owner did not inform the neighbours in advance, due to which the workers were unaware of such a major activity underway in their immediate neighbourhood. While the workers were busy in work, a huge stone that flew from the blasting site hit him, leading to a serious head injury and death. The others were injured when some small stones hit them on the body, including the head. We have lodged a case, and further investigation is underway," he said.*

- *Flyrock 249:* On October 4, 2024, a blast at a construction site in Halifax, Nova Scotia, launched *flyrock debris* that landed on the driveway of Thiago Andrade's home, barely missing his car and front steps (Macdonald, 2024).

  > *Residents in the Spryfield area of Halifax are speaking out about ongoing blasting from two construction sites off Herring Cove Road – with one neighbour saying a "close call" with a rock could have killed someone.*
  >
  > *Thiago Andrade, who lives across the street from the blasting at the Green Acres construction site, says he was working from home on Oct. 4 when he felt and heard a rumble. "I heard this huge shake. About 10 seconds after the shake, I heard this noise, as if something had hit the house," he recalled. It turned out that a large rock had flown onto his driveway, barely missing his car and front steps. He estimates the rock weighs a pound.*

- *Flyrock 250:* In May 2024, a blast at a road construction site in British Columbia ejected a single rock (about 1 cubic foot in size) that struck and damaged high-voltage power lines on one side of the highway.[7]

  > *Blast mats had been placed before the blasting began, and no workers or other persons were exposed to the ejected rock, as the blast hazard area, including the highway, had been closed to traffic, and the worksite had been secured.*

- *Flyrock 251:* On October 14, 2024, a blast at a quarry in Banteay Meas district, Cambodia, showered *flyrock debris* that damaged six houses 300 metres from the foot of the mountain and injured four people (Soreachny & Sreypich, 2024).

  > *Phnom Meas Lime and Powder Enterprise in Kampot province has temporarily suspended rock blasting activities after authorities found that they used improper techniques, which injured four people and damaged nearby homes. District police chief Nak Dim told*

[7] "Recent Work-Related Incidents Reported to Worksafe BC," *Council of Construction Associations*, June 11, 2024. https://cocabc.ca/recent-work-related-incidents-reported-to-worksafebc-47/

> *CamboJA News that the local authorities were working on the case. He confirmed the number of casualties, adding that six houses were affected.*
> *"The authorities have always advised the team and foremen at the site, but that day, they probably used the wrong techniques," Dim said.*
> *The company compensated the victims who received medical treatment and repaired the damaged houses after it was informed of the incident, he added.Regarding the incident, he said the company paid compensation to the victims. Those who were seriously injured went to Phnom Penh for treatment. The company will repair the houses that were damaged. …*
> *Resident Khieu Sarith of Chrak Khlai village, Touk Meas Khang Lech commune, told CamboJA News that four villagers were seriously injured and were being treated at a hospital. According to him, the company has not paid any compensation to the injured people as it is waiting for them to return home after receiving treatment.*

- *Flyrock 252:* On August 17, 2004, a blast at a quarry in Winsted, Connecticut, launched thousands of pieces of *flyrock debris*, some three times the size of softballs, that injured two people, one seriously, and damaged the Waste Management facility and several vehicles at 185 Torrington Road. The flyrock debris field covered an area extending 274 metres from the blast site (Klimanowski, 2004).

> *One Waste Management employee was hit in the leg with a rock but refused medical treatment. Another employee, Cecil Brewer, was in the front office at the time of the explosion and was hit with glass fragments after a rock came crashing through the office window.*
> *"When the blast came, it was too high powered," said Mr. Brewer, who has worked for Waste Management for the past five years and is accustomed to the frequent blasting. "When the rocks came through the window, I turned around and just prayed nothing would hit me."*
> *Afterward, a handful of vehicles sat in the parking lot with the windshields and other windows smashed. About a half-dozen holes were evident in the building's facade, and some of the rocks landed just inches away from employees on the floor inside.*
> *Just before the explosion, traffic on both sides of Torrington Road was at a halt for safety reasons, a practice that happens before each explosion. Mr. Beadle said for some reason, a massive amount of "fly rock" was emitted from Tuesday's blast. He estimated that thousands of pieces of rock could have landed as far as 300 yards [274 metres] away from the blast site….*
> *About 20 Waste Management employees were in or around their work site when the explosion occurred. As the rocks showered down from above, many of them dove for cover, ducking down in their vehicles, sliding under vehicles, or hiding behind equipment big enough to shelter them from falling rock.*

- *Flyrock 253:* On March 12, 2024, a blast at a construction site in Uttar Pradesh, India, launched *flyrock debris* that struck and killed three and injured seven labourers.[8]

> *At least three people died and seven labourers were injured in an explosion during rock blasting when a portion of a hill fell on them in Uttar Pradesh's Mahoba on Tuesday, the police said. The incident took place near Pahara village of Kabrai Police Station area of the district, they said.*
> *On receiving the information, the police reached the spot and launched a rescue operation to retrieve the injured. Three people were pulled out from the debris and taken to the hospital, where the doctor declared them dead. However, the injured brought to the hospital are undergoing treatment. The officials informed the family members of the workers.*
> *Mahoba District Magistrate Mridul Chaudhary said, "The workers were engaged with the government lease work when the accident suddenly happened. Three labourers working at the site died after being buried under the debris, while the condition of one remains*

[8] "Three Killed, Seven Injured in Explosion During Rock Blasting in Uttar Pradesh," *Etv Bharat*, March 12, 2024. https://www.etvbharat.com/en/!state/explosion-during-rock-blasting-in-uttar-pradesh-enn24031204375

> *critical. Seven other people buried under the debris have been rescued and admitted to a hospital for treatment." Top officials, including SP Aparna Gupta, reached the spot*

- *Flyrock 254:* On March 5, 2025, a miner was fatally injured at a limestone quarry in Jersey, Illinois, when *flyrock debris* from blasting operations struck him. The miner was assisting in detonating the explosives. According to the news release issued by the U.S. Mine Safety & Health Administration, this has been the tenth fatality reported in 2025.[9]
- *Flyrock 255:* On April 17, 2025, a blast at the town quarry in Westerly, Rhode Island, operated by Maine Drilling and Blasting, launched *flyrock debris* that showered the neighbourhood and damaged several homes 200 yards (183 metres) from the quarry. Rocks struck four houses[10] and penetrated the roofs of two houses on Asaway Road, barely missing the expensive roof solar panels of one (Perik, 2025). The flyrock debris is thought to have been caused by a geological anomaly.[11]

  > *Multiple homes in the town sustained damage after rocks flew from a nearby quarry during blasting. The debris just missed McColl's expensive solar panels. Just a few houses down, there was another home with another hole. "It's like a meteor fell from the sky. After the explosion, a rock came flying and landed in the middle of the road," resident Nate Harrington said. Some rocks were the size of a baseball; others were larger than a size-11 shoe. The debris nearly crashed into cars. If someone were outside, they would have gotten nailed. They would have gotten hurt," a resident said. Neighbors said the quarry is approximately 200 yards away from the houses that were impacted. The town says at least four similar incidents have been reported. In 2018, two Westerly Department of Public Works employees had to go to the hospital after being struck by granite during a scheduled blast. Now, some neighbors are demanding a change. "Rocks are flying into people's houses. It's just ridiculous. It's just not right, and the town, somebody has to stop it."*
- *Flyrock 256:* On August 20, 2024, a blast at the Roxborough surface coal mine in Muswellbrook, NSW, launched *flyrock debris* 100 metres from the blast site and struck and damaged an onsite dozer, excavator, and haul truck (NSW Government, 2024).

  > *A worker was operating a Caterpillar D11T dozer in the Roxburgh Pit at the mine about 7.30 am on Tuesday, 20 August 2024. The dozer was operating on a bench directly in front of and below a Liebherr R-996 excavator. The excavator was loading a 793D haul truck. The bench being excavated had been fired by a planned shot on 20 May 2024.*
  >
  > *While the dozer operator was pushing blast waste material on the lower bench, an unplanned initiation of explosives occurred. The explosion caused multiple pieces of flying rock and parts from the dozer blade to be projected about 100 m from the incident site. The location of the explosion left a crater measuring 1.8 m deep and about 3.5 m in width.*

5. QUANTITATIVE ANALYSIS OF FLYROCK INCIDENTS

A non-theoretical *quantitative* study of actual distances that flyrock has been launched from a blast site was undertaken by Sevelka (2022) (May 2021) and included in that analysis are 92 incidents of flyrock. Since then, more incidents of flyrock have been documented, expanding the data set from 92 to 147 incidents of flyrock (May 2025). Where flyrock debris has been launched over a large area or in more than one direction, only the furthest distance of the flyrock from the blast site is recorded, summarized, and arrayed in the following bar chart.

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[9] https://www.msha.gov/sites/default/files/Data_Reports/Fatals/Enforcement/2025/March%205%2C%202025%20-%20Fatality%20Alert%20-%20Calhoun%20Quarry.pdf

[10] "Westerly residents say homes were damaged by flying rocks after scheduled blasting," *The Western Sun,* April 21, 2025. https://www.thewesterlysun.com/news/westerly/westerly-residents-say-homes-were-damaged-by-flying-rocks-after-scheduled-blasting/article_0655c2bb-9f26-4ccb-b16b-091ce26c181a.html

[11] Geological condition may have caused damage in Westerly quarry blast, says fire marshal. https://turnto10.com/news/local/geological-condition-may-have-caused-damage-in-westerly-quarry-blast-says-fire-marshal-rhode-island-ashaway-road-rocks-roofs-april-23-2025.

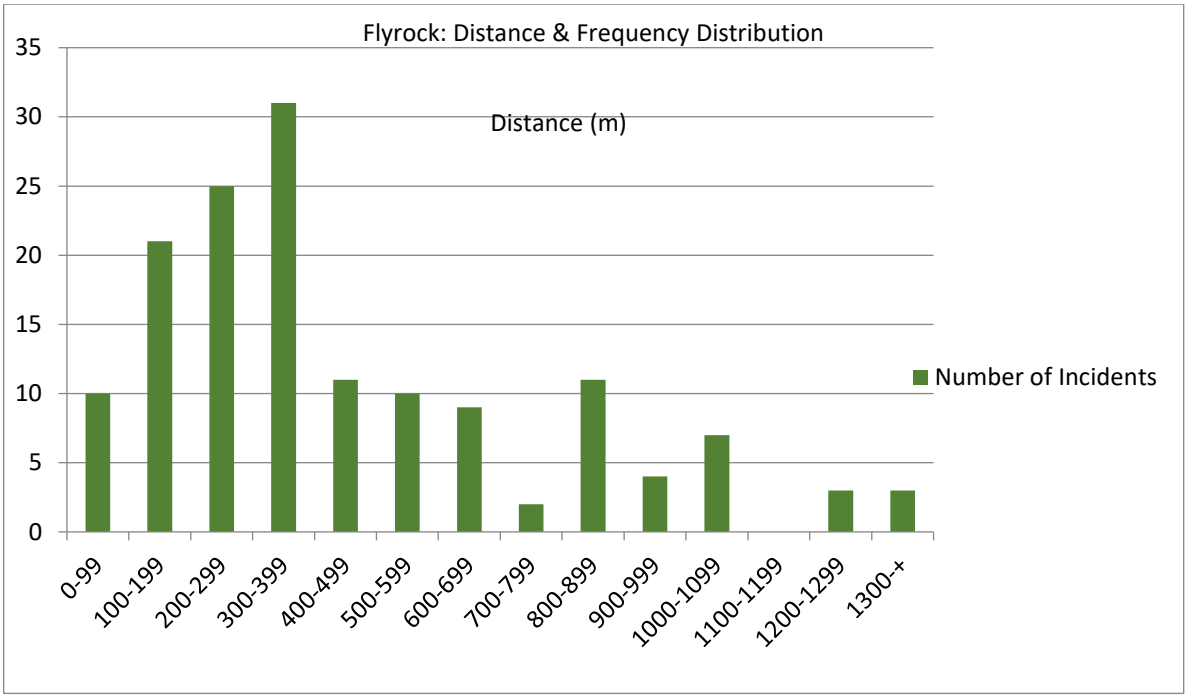

Figure 1: Analysis of Flyrock Travel Distances (May 2021 to May 2025)

- An analysis of 147 *flyrock* incidents, where the distance from the blast site is known, indicates that 96% (141) of the *flyrock* incidents occurred within 1,099 metres, and 98% (144) occurred within 1,299 metres. The number of *flyrock* incidents within each interval, starting at between 0-99 metres, and the average distance travelled within each interval are summarized as follows:

Table 1: Interval Distribution and Frequency of Flyrock Distances

Metres	*0-99*	*100-199*	*200-299*	*300-399*	*400-499*	*500-599*	*600-699*	*700-799*	*800-899*	*900-999*	*1000-1099*	*1100-1199*	*1200-1299*	*1300+*
Incidents	10	21	25	31	11	10	9	2	11	4	7	0	3	3
Cumulative	-	31	56	87	98	108	117	119	130	134	141	141	144	147
Average (m)	54	149	241	326	443	511	618	701	803	912	1013	-	1206	2307
% of Total	7%	14%	17%	21%	7%	7%	6%	1%	7%	3%	5%	0%	2%	2%
Cumulative %	-	21%	38%	59%	67%	73%	80%	81%	88%	91%	96%	96%	98%	100%

- At 91% of the 147 *flyrock* incidents, 134 *flyrock* incidents in ascending order reached a distance up to the 900 – 999 metre intervals, and, at 96%, which accounts for the first 141 *flyrock* incidents in ascending order, flyrock reached a distance up to the 1000 – 1099 metre interval.
- Based on this updated study of *flyrock* incidents (May 2025), the designated blast area (onsite safety zone) would have to be approximately 1,000 metres to effectively prevent 96% of *flyrock* incidents from leaving the boundaries of a blasting quarry site, equivalent to a 1,000-metre setback (excavation limit).

6. SETBACKS AND SEPARATION DISTANCES IN VARIOUS JURISDICTIONS

Setbacks and Separation distances for blasting quarries in the various jurisdictions listed below range from 500 metres to 3,219 metres (Tippecanoe, Indiana), and are in sharp contrast to the wilfully reckless and negligent 30-metre setback permitted in Ontario, Canada, under the ARA:

- 2 miles (3,219 metres) from any site with 100 or more residential homes, quarries are prohibited (Tippecanoe County, Indiana)[12]
- 3,000 metres from a residential, commercial, or industrial area (Nigeria)[13]
- 5,000 feet (1,524 metres) quarries, rock crushers, gravel pits, cryptocurrency mining, landfills, adult entertainment and methadone clinics not permitted within this distance of a residence, school, church and other uses that include various public facilities that serve the community's health, education, and public welfare needs (DeKalb County, Tennessee) (Page, 2024).
- 5,000 feet (1,524 metres) quarries, rock crushers, and gravel pits not permitted within this distance of sensitive land uses and protects the inhabitants from uses of property detrimental or likely to be detrimental to their *health, safety, and welfare* (Grundy County, Tennessee)[14]
- >1,000 metres from a residential or sensitive land use, boundary of a Settlement Area or Waterfront designation (Algonquin Highlands, Ontario, Canada)[15]
- 1,000 metres minimum buffer distance from existing or proposed residential development where blasting is involved (Newfoundland and Labrador, Canada)[16]
- 1,000 metres from the planned maximum extent of quarry operations to any sensitive use (Tasmania, Australia)[17]
- One-half mile (805 metres) from any residential zone (Palm Springs, California)[18]
- 800 metres separation between blasting and offsite structures (Nova Scotia, Canada)[19]
- 600 metres minimum from residential, commercial, and mixed-use (Quebec, Canada)[20]
- 600 metres from any drinking water supply well (New Brunswick, Canada)[21]
- 500 metres minimum separation distance from sensitive land use (Timmins, Ontario, Canada)[22]
- 500-metre radius from blast site treated as onsite danger zone (Dangers due to blasting projectiles) (India).

In Ontario, Canada, according to the ARA, flyrock is not to be launched beyond the boundaries of a quarry site. A licensee or permittee must take all "reasonable" measures to prevent flyrock from leaving the site during blasting if a "sensitive receptor" is located within 500 metres of the boundary of the site. ARA defines "sensitive receptor":

a) a school or childcare centre, or

b) any residence or facility at which at least one person sleeps, including a long-term care home, hospital, trailer park, or campground.

"Facility", another undefined term in the ARA, is a broad and all-encompassing term, as indicated by the following sources:

1. Merriam-Webster defines "facility" as something that makes an action, operation, or course of conduct easier, usually used in the plural. It can also refer to a building or area that is used for a particular activity or purpose.[23]

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12 *Rogers Group, Inc. v. Tippecanoe County*, 52 N.E. 3d 848 (2016), https://case-law.vlex.com/vid/rogers-grp-inc-v-887446794

13 https://www.nesrea.gov.ng/wp-content/uploads/2020/02/Quarrying_and__Blasting_Operations.pdf?form=MG0AV3

14 *Tinsley Properties, LLC v. Grundy County*, No. M2022-01562-COA-R3-CV, Tenn: Court of Appeals, 2023, https://law.justia.com/cases/tennessee/court-of-appeals/2024/?page=2

15 https://www.algonquinhighlands.ca/municipal-services/planning/official-plan/

16 Department of Municipal and Provincial Affairs, 1996, *City Sand and Gravel Limited v. Newfoundland (Municipal and Provincial Affairs),* 2007 NLCA 51 (CanLII), <https://canlii.ca/t/1sfnv>, retrieved on 2025-01-06. Leave to appeal to the Supreme Court of Canada denied. *City Sand and Gravel Limited and O.D. Holdings Limited v. Her Majesty the Queen in Right of Newfoundland, as represented by The Honourable Minister of Municipal and Provincial Affairs*, 2008 CanLII 1399 (SCC), <https://canlii.ca/t/1vgkt>, retrieved on 2025-01-06

17 Tasmania EPA Quarry Code of Practice, 3rd Ed Edition, *May, 2017*, p. 10. https://epa.tas.gov.au/Documents/Quarry%20Code%20of%20Practice%20May%202017%20-%20web.pdf

18 City of Palm Springs Zoning Code § 93.23.03 B. https://ecode360.com/43605872#43605868

19 The NSE Pit and Quarry Guidelines (1999) stipulated setbacks to prevent structural and environmental damage as well as the requirements for pre-blast surveys, blast monitoring, and blast designs. https://novascotia.ca/nse/issues/docs/Pit_and_Quarry_Guidelines.pdf

20 "11. The operating site of a new quarry must be located at a minimum distance of 600 m from any dwelling, unless the dwelling is owned or rented to the owner or operator of the quarry." 10. It is prohibited to establish a new…quarry, the operating site of which is located in a territory zoned by the municipal authorities for residential, commercial or mixed purposes (commercial residential0. It is also prohibited to establish a new quarry less than 600 m from such territory…". https://www.legisquebec.gouv.qc.ca/en/document/cr/q-2,%20r.%207

21 Rock Quarry Siting Standards. Effective August 2012. https://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/Air-Lair/RockQuarrySitingStandards.pdf

22 City of Timmins Zoning By-law 2011-7100, as amended. https://timmins.civicweb.net/filepro/documents/238/?preview=13810

23 https://www.merriam-webster.com/dictionary/facility

2. Cambridge Dictionary: Defines "facility" as a place, especially including buildings, where a particular activity happens. It can also refer to the ability to do something easily or well.[24]
3. Oxford Advanced Learner's Dictionary: Defines "facility" as buildings, services, equipment, etc., that are provided for a particular purpose. It can also refer to a place used for a particular activity or a special feature of a machine or service that makes it possible to do something extra.[25]

A *Residence* or *Facility,* where at least one person sleeps, includes, but is not limited to, the following:

- *Residential Homes:* Houses, apartments, and condos where individuals or families reside.
- *Hotels and Motels:* Lodging establishments offering rooms for short-term stays.
- *Inns:* Establishments providing overnight accommodations for travellers and guests, often with a more intimate and cozier atmosphere (e.g., The Liberty Inn, former Cataract Inn, Hamlet of Cataract, Caledon, Ontario).
- *Bed and Breakfasts (B&Bs):* Home-like establishments offering overnight accommodations and breakfasts
- *Hospitals and Healthcare Facilities*: Places where patients may stay overnight for medical treatment, including hospitals, clinics, and rehabilitation centers.
- *Nursing Homes and Elderly Care Facilities:* Long-term care facilities for the elderly or individuals with disabilities.
- *Childcare Centers and Boarding Schools:* Facilities where children and students may reside overnight, such as boarding schools and residential childcare centers.
- *Campgrounds and RV Parks:* Areas designated for camping, where individuals may sleep in tents, RVs, or cabins.
- *Shelters and Temporary Housing:* Facilities providing temporary accommodation for individuals experiencing homelessness or other emergencies.
- *Correctional Facilities:* Prisons, jails, and other detention centres where inmates reside.
- *Military Barracks:* Housing for military personnel.
- *Dormitories and Student Housing:* Accommodations for students, typically on or near college and university campuses.
- *Group Homes:* Residential facilities for individuals with special needs or disabilities.
- *Monasteries, Convents, and Religious Retreats:* Facilities where members of religious orders or individuals on retreat may reside.
- *Golf Resort with Lodging Facilities:* Golf courses that offer overnight accommodation for guests (e.g., TPC Toronto at Osprey, Caledon, Ontario).

As an example, in the Town of Caledon, Ontario, several zoning categories permit residential or accommodation-related uses:

- *A1 (Agricultural), A2 (Rural),* and *A3 (Small Agricultural Holdings)* permit an "Accessory Apartment," Bed and Breakfast Establishment," and "Detached Dwelling."[26]
- *A1 (Agricultural)* and *A2 (Rural)* permit an "Accessory Dwelling" and "Accessory Bunkhouse."
- *OS (Open Space)* permits an "Accessory Dwelling Unit."[27]
- *CV (Village Commercial)* permits "Accessory Dwelling" and "Accessory Dwelling Unit."[28]
- *Beacon Hall Lands (Part of Lots 16, 17, 18, 19, 20 & 21, Concession 3 WHS and Part of Lots 16, 17 & 18), Concession 4 WHS)*[29]
    - *OS (Open Space)* permits "Accessory House,"
    - *A1 (Agricultural)* permits "Apartment-in-House Unit," Bunkhouse," "Accessory House," and "One-Family House."

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[24] https://dictionary.cambridge.org/dictionary/english/facility
[25] Oxford Advanced Learner's Dictionary, s.v. "facility," accessed https://www.oxfordlearnersdictionaries.com/definition/english/facility.
[26] Caledon Zoning By-law – Section 10 Agricultural and Rural Zones. https://www.caledon.ca/en/town-services/resources/Documents/business-planning-development/zoning-by-law/2023/Nov-11-2024/Section-10-ACCESSIBLE.pdf
[27] https://www.caledon.ca/en/town-services/resources/Documents/business-planning-development/zoning-by-law/June-09-2022/Section-12
[28] https://www.caledon.ca/en/town-services/resources/Documents/business-planning-development/zoning-by-law/2023/Nov-11-2024/Section-7-ACCESSIBLE.pdf
[29] https://www.caledon.ca/en/town-services/resources/Documents/business-planning-development/zoning-by-law/March-24-2022/Section-13.2-ACCESSIBLE.pdf

The broad interpretation of "facility" highlights the critical need for stringent separation distances and safety measures to protect sensitive receptors, sensitive land uses, and activities from the risks associated with blasting operations. Additionally, it reinforces the need to carefully read land use documents (e.g., Zoning By-laws, Official Plans, Provincial Planning Statement, 2024,[30] MOECP D-6 Land Use Compatibility Guidelines[31]), as permitted uses often vary between municipalities, even when zones share similar labels, such as "Agricultural." Safeguarding the environment and protecting the health, safety, and welfare of the community from the potentially deadly consequences of flyrock debris is the critical obligation of local government. However, achieving this requires a comprehensive understanding of the risks posed by blasting operations — an understanding that is often absent in municipalities and among their planning staff. Bridging this awareness gap is essential to developing proactive and permanent land use compatibility measures that prioritize safety and environmental preservation.

7. CONCLUSION

These findings underscore the critical need for updated and more stringent safety regulations around blasting operations in Ontario and elsewhere, where land use incompatibility is an issue and the community is at risk. Here are some key insights that can be drawn from the analysis:

1. *Current Safety Measures are Insufficient:* The data indicates that flyrock can travel significant distances, often well beyond estimated safety setbacks. The fact that 96% of incidents occur within 1,099 metres of the blast site suggests that existing safety measures are inadequate to protect the public.
2. *Need for Extended Safety Zones:* To effectively contain flyrock within the boundaries of blasting sites, safety zones and permanent onsite setbacks (excavation limits) must be significantly expanded to a minimum of 500 metres.
3. *Permanent Offsite Separation Distances:* Protecting the environment and safeguarding sensitive land uses and activities requires a minimum separation distance of 1,000 metres, measured from the site boundaries, aligning with best practices adopted in other jurisdictions.
4. *Regulatory Oversight:* The current lack of definition and protocols for flyrock in the Ontario Aggregate Resources Act highlights a critical gap in regulatory oversight. Clear definitions and stringent safety protocols must be established to ensure public safety.
5. *Competency of Blasters:* The absence of licensing requirements for blasters in Ontario raises concerns about the competency and safety practices of those handling explosives. Mandatory certification and regular training are essential to minimize the risk of flyrock incidents.
6. *Transparency and Reporting:* The aggregate industry's underreporting of flyrock incidents needs to be addressed. Mandatory reporting and public disclosure of all incidents are crucial to understanding the full scope of the problem and implementing effective solutions.
7. *Community Involvement:* Municipalities and local communities must be actively involved in the decision-making process regarding land use compatibility and safety regulations. Public awareness campaigns and community engagement can help ensure that residents are informed and protected.

By implementing these insights, regulators and municipalities can better protect the environment and safeguard employees ' and residents' health, safety, and well-being near blasting operations. The findings underscore the urgent need to implement comprehensive reforms to address the dangers of flyrock effectively and permanently.

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